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Materiel Test Procedure 9-2-064  
General Equipment Test Activity

U.S. ARMY TEST AND EVALUATION COMMAND  
COMMODITY ENGINEERING TEST PROCEDURE

CRANE, SHOVEL, TRACKED & WHEELED

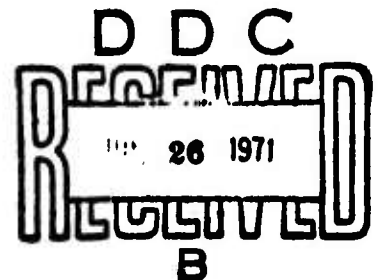
1. OBJECTIVE

This document provides test methodology and testing techniques to determine the technical performance and safety characteristics of crane shovels and associated accessories as described in Materiel Needs (MN) and to determine the item suitability for service tests.

2. BACKGROUND

This MTP consists of a basic unit (crane-shovel), upon the front of which can be attached any one of the following accessories:

- a. Crane lifting hook, block, and boom.
- b. Clamshell.
- c. Backhoe.
- d. Shovel.
- e. Dragline.
- f. Pile driver.



The assembly then takes the name of the front-end attachment. A description of each attachment and other terms (including front-end) peculiar to crane-shovel operation can be found in Power Cranes and Shovels, Commercial Standard CS 90-58. The basic unit is defined in and tested by completing the procedures of this MTP; the front-end attachments minus the pile driver attachments are tested by completing the procedures in MTP 9-2-071; the pile driver attachment is tested by completing the procedures in MTP 9-2-169.

The crane shovel basic unit consists of a superstructure and a carrier. The superstructure contains an operator's cab, an engine, and all sheaves, gears, pulleys, wire ropes, etc., necessary to mount and operate the previously mentioned front-end attachments. The carrier, either wheeled or tracked, supports and provides the superstructure a mobile platform. Typically, the tracked mounted crane, a single engine and operator's cab is used to drive and control the carrier motion and crane shovel operations. The cab and engine are both superstructure mounted. The wheel mounted crane shovel may have one or two engines and one or two operator's cabs. Typically, the carrier is self-propelled and contains a cab with all controls for carrier propulsion. The superstructure has its own engine and an operator's

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cab for powering and controlling the crane shovel attachments.

3. REQUIRED EQUIPMENT

- a. Electromagnetic interference (EMI) testing facility-shielded room or open area.
- b. Temperature and humidity environment control chamber.
- c. Rain test course.
- d. Platform weight-measuring scale.
- e. Tension dynamometer.
- f. Adapter pulley with diameter equal to wheeled test-item hand steering wheel diameter.
- g. Pressure-type indicating device suitable for attachment to test item clutch pedal.
- h. Measuring tapes
- i. Inclinometer.
- j. SR-4 resistance strain gages conforming to Baldwin-Lima-Hamilton Corporation Bulletin 279 and 279A
- k. EMI instruments and antennas per MIL-STD-461
- l. Sound level meter per ASA S1. 4-1961.
- m. Octave band analyzer per ASA S1.6-1960.
- n. Tachograph.

4.

REFERENCES

- A. Army Regulation 70-38 Research and Development: Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions.
- B. USAMC Pamphlet 706-134 Engineering Design Handbook: Maintainability Guide for Design.
- C. USATECOM Regulation 70-23 Research and Development: Equipment Performance Reports (EPRs).
- D. USATECOM Regulation 385-6 Safety: Verification of Safety of Materiel During Testing.
- F. USATECOM Regulation 700-1 Quality Assurance: Value Engineering.
- F. USATECOM Regulation 750-15 Maintenance of Supplies and Equipment: Maintenance Evaluation During Testing.
- G. USAGETA Document Human Factors Evaluation Data for General Equipment (HEDGE).
- H. FED-STD-101 Preservation, Packaging, and Packing Materials, Test Procedures.
- I. FED-STD-141 Paint, Varnish, Lacquer, and Related Materials; Methods of Inspection, Sampling and Testing.
- J. FED-STD-151 Metals; Test Methods.
- K. FED-STD-406 Plastics, Methods of Testing.
- L. MIL-STD-129 Marking for Shipment and Storage.
- M. MIL-STD-130 Identification Marking of US Military Property.
- N. MIL-STD-162 Material Handling Equipment, Preparation for Shipment, Storage, Cyclic Maintenance, Outline Testing and Process.

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- O. MIL-STD-209 Slings Eyes and Attachments for Lifting and Tying Down Military Equipment.
- P. MIL-STD-271 Non-Destructive Testing Requirements for Metals.
- Q. MIL-STD-448 Test Methods of Construction and Industrial Machinery.
- R. MIL-STD-461 Electromagnetic Interference Characteristics Requirements for Equipment.
- S. MIL-STD-462 Electromagnetic Interference Characteristics, Measurement of.
- T. MIL-STD-463 Definitions and Systems of Units - Electromagnetic Interference Technology.
- U. MIL-STD-810 Environmental Test Methods.
- V. MIL-STD-882 System Safety Program for Systems and Associated Subsystems and Equipment: Requirements for.
- W. MIL-STD-1186 Cushioning, Anchoring, Bracing, Blocking, and Waterproofing; With Appropriate Test Methods.
- X. MIL-STD-1400 Engines, Gasoline or Diesel, Methods of Test.
- Y. MIL-STD-1472 Human Engineering Design Criteria for Military Systems, Equipment and Facilities.
- Z. MIL-C-104 Crate, Wood, Lumber and Plywood Sheathed, Nailed and Bolted.
- AA. MIL-P-116 Preservation, Methods of.
- AB. MIL-P-514 Plate, Identification, Instruction and Marking, Blank.
- AC. MIL-T-704 Treatment and Painting of Material.
- AD. MIL-C-3580 Cranes, and Crane-Shovels, Truck, Crawler, and Wheel Mounted, Full Revolving, and their Attachments, Packaging of.
- AE. MIL-E-10062 Engine, Preparation for Shipment and Storage of.
- AF. MIL-E-11275 Engine, Gasoline, Industrial Type, General Specifications for.
- AG. MIL-E-11276 Engine, Diesel, Industrial, Medium and High Speed, General Specification for.
- AH. MIL-T-46729 Tire, Pneumatic, 75 Percent Minimum Natural Rubber Content, for Military Ground Vehicles.
- AI. MIL-W-52574 Welding and Welding Procedure.
- AJ. MS 33586 Metals, Definition of Sissimilar.
- AK. MTP 2-2-500 Vehicle Characteristics.
- AL. MTP 2-2-501 Amphibious Vehicle Characteristics.
- AM. MTP 2-2-502 Inspection (Automotive).
- AN. MTP 2-2-503 Maintenance.
- AO. MTP 2-2-505 Preliminary Operation.
- AP. MTP 2-2-506 Durability Testing of Wheeled Vehicles.
- AQ. MTP 2-2-507 Durability Testing of Tracked Vehicles.
- AR. MTP 2-2-508 Safety Evaluation (Automotive).
- AS. MTP 2-2-601 Electrical Systems (Automotive).
- AT. MTP 2-2-602 Acceleration - Maximum and Minimum Speeds.

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AU. MTP 2-2-603 Vehicle Fuel Consumption.  
AV. MTP 2-2-607 Engine and Power Train Cooling Systems (Vehicle).  
AW. MTP 2-2-608 Braking, Wheeled Vehicles  
AX. MTP 2-2-609 Steering  
AY. MTP 2-2-610 Gradeability and Side Slope Performance Mobility.  
AZ. MTP 2-2-612 Fording  
BA. MTP 2-2-613 Broad Band Radio Interference Tests of Vehicle and Electrical Equipment Noncommunication.  
BB. MTP 2-2-614 Toxic Hazards Test for Vehicles.  
BC. MTP 2-2-619 Soft-Soil Vehicle Mobility  
BD. MTP 2-2-650 Cold Starting and Warm-up.  
BE. MTP 2-2-700 Laboratory Tests of Reciprocating Internal Combustion Engines  
BF. MTP 2-2-702 Effects of Altitude on Automotive Engines.  
BG. MTP 2-2-703 Laboratory Tests of Power Train Components.  
BH. MTP 2-2-704 Tires.  
BI. MTP 2-2-707 Kits (Vehicles)  
BJ. MTP 2-2-708 Personnel Heating Systems.  
BK. MTP 2-2-800 Center of Gravity  
BL. MTP 2-2-801 Load Distribution and Ground Pressure.  
BM. MTP 2-2-803 Human Factors Engineering (Vehicles).  
BN. MTP 2-4-001 Desert Environmental Test of Wheeled and Tracked Vehicles.  
BO. MTP 2-4-002 Arctic Environmental Test of Wheeled and Tracked Vehicles.  
BP. MTP 2-4-003 Tropic Environmental Test of Wheeled and Tracked Vehicles.  
BQ. MTP 9-2-071 Buckets-Clamshell, Tracked & Wheeled Attachments  
BR. MTP 9-2-155 Motors, Electrical  
BS. MTP 9-2-169 Pile Driving Rigs.  
BT. MTP 9-2-503 Durability.  
BU. MTP 9-4-001 Desert Environmental Test of Construction, Support and Service Equipment.  
BV. MTP 9-4-003 Tropic Environmental Test of Construction, Support and Service Equipment.  
BW. MTP 9-4-005 Arctic Environmental Test of Support and Service Equipment.  
BX. MTP 10-2-500 Physical Characteristics  
BY. MTP 10-2-501 Operator Training and Familiarization.  
BZ. MTP 10-2-503 Surface Transportability (General Supplies and Equipment.)  
CA. MTP 10-2-505 Human Factors Evalaution  
CB. MTP 10-2-507 Maintenance Evaluation.  
CC. MTP 10-2-508 Safety.  
CD. MTP 10-2-511 Quality Assurance.  
CE. MTP 10-2-512 Reliability.

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- CF. NEMA LC-1 Standards for Industrial Controls.
- CG. NEMA MG-1 National Electric Manufacturer's Association Test and Performance - AC and DC Fractional and Integral Horsepower Motors, Part 12.
- CH. Joint Industrial Council EGP-1-1967 Electrical Standards for General Purpose Machine Tools.
- CI. Society of Automotive Engineer, Inc. Document 1969 SAE Handbook.
- CJ. National Safety Council, 425 North Michigan Avenue, Chicago, Illinois 60611 Operation of Power Shovels, Dragline and Similar Equipment, Data Sheet D-271, Stock No. 12304; Wire Rope, Safe Loads for Slings, Data Sheet D-380, Stock No. 12304; and Safe Use of Heavy Duty Equipment on Construction Jobs, Industrial Safety Reprint No. 130, Stock No. 12913.
- CK. Power and Crane Shovel Association, 75 West Street, New York 6, New York 125 Ways to Better Power Shovel-Crane Operation.
- CL. American Standards Association, 70 East 45th Street, New York, New York American Standard Safety Code for Cranes, Derricks and Hoists. B30.2-1943 (R 1952).
- CM. ASA S1.6-1960 Preferred Frequencies for Acoustical Measurements.
- CN. ASA S1.4-1961 General Purpose Sound Level Meters.
- CO. Commercial Standard CS 90-58, U.S. Department of Commerce document issued by Office of Technical Services, Commodity Standards Division, Power Cranes and Shovels.

## 5. SCOPE

### 5.1 SUMMARY

This materiel test procedure describes the following tests to be conducted on crane shovels.

a. Preparation for Test - A determination of the condition of the test item upon its arrival and other preparatory procedures to be completed prior to active testing. These procedures consist of the following:

- 1) Packaging and test item inspection.
- 2) Inventory check.
- 3) Inspection and preliminary operation.
- 4) Physical characteristics.
- 5) Operator training and familiarization.
- 6) Preoperational checks.
- 7) Laboratory and bench tests.

b. Crane Stability - An evaluation to determine the conditions of minimum crane shovel stability (as a function of boom angle, working radius, and work load).

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c. Load Strain Test - An evaluation to determine the load-bearing and strain resistance characteristics of the crane support structure including gantry and A-frame, as appropriate.

d. Crane Hoist Line Speed and Power Test - An evaluation to determine the power and speed developed by each hoist mechanism under various load conditions.

e. Mobility - An evaluation to determine the speed, maneuverability, and other characteristics related to the mobility of the crane shovel.

f. Brake Tests - An evaluation to determine the dynamic and static brake characteristics of the crane carrier. Also, an evaluation to determine the superstructure swing and drum brake characteristics.

g. Fuel Consumption Test - An evaluation to determine the fuel-using characteristics of the crane shovel as a function of load and speed.

h. Environment Testing - An evaluation to determine the ability of the test item to withstand adverse climatic conditions without suffering performance degradation.

i. Electromagnetic Interference - An evaluation to determine radio frequency noise generating characteristics during normal operation of test item with all noise suppression components installed.

j. Durability - An evaluation to determine ability of test item to withstand normal operational stresses without failure.

k. Transportability - An evaluation to determine the ability of the test item to withstand the forces which it will experience during normal transport.

l. Maintenance Evaluation - To determine and verify the maintenance/maintainability characteristics and requirements of the test item; an appraisal of the design and of the maintenance test package, and the calculation of indicators which express the effects of the preceding aspects.

m. Reliability - An evaluation to determine the probability that the test item will perform its intended function for a specified interval under stated conditions.

n. Safety - An evaluation of the test item safety characteristics revealed during operational use and determinations of "Safety Confirmation".

o. Human Factors Evaluation - An evaluation to determine the adequacy of the design and performance characteristics of the test item and associated equipment in terms of conformance to accepted human factors engineering design criteria. Included, as a subtest, is an evaluation to determine volume and frequency range of noise generated by test item.

p. Value Analysis - An evaluation directed at analyzing the primary function and features of the test item for the purpose of reducing the cost of the test item without compromising performance and safety characteristics.

q. Quality Assurance - An evaluation of the test item with the objective of appraising the quality of workmanship and the degree of material freedom from defects and flaws.

## 5.2 LIMITATIONS

The procedures are limited to self-powered wheeled and tracked crane-shovel basic units as defined in the Background paragraph of this MTP. The tests assume a crane-shovel configuration of a superstructure mounted on a carrier, but, may also be used in cases where the crane superstructure and carrier are an integral unit. The MTP is intended to be used as a basic guide in preparing actual test plans for the subject equipment. Specific criteria and test procedures must be determined only after careful appraisal of pertinent MN's, and any other applicable documents.

## 6. PROCEDURES

### 6.1 PREPARATION FOR TEST

#### 6.1.1 Initial Inspection

##### 6.1.1.1 Shipping and Packaging Inspections

a. Examine the preservation and packaging of the test item and determine any instances of damage and nonconformance with the following specifications, as applicable:

- 1) Container markings - MIL-STD-129.
- 2) Packaging of test item and attachments - MIL-C-3580B.
- 3) Preparation for storage, shipment, and cyclic maintenance of test item - MIL-STD-162C.
- 4) Crates, Wood, Lumber-and-Plywood Sheathed, Nailed and Bolted - MIL-C-104.
- 5) Shipment and Storage of Engines and Motors - MIL-E-10062.
- 6) Blocking, Bracing, and Anchoring Procedures - MIL-STD-1186.
- 7) Methods of Preservation - MIL-P-116.



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6.1.1.2 Test Item Inspection

The test item shall have been marked in accordance with MIL-STD-130, bear identification plates conforming to MIL-P-514 and, in addition, shall be visually inspected for evidence of defects, damage and wear in its manufacturing, materials, and workmanship.

a. Nonmachined metal surfaces shall be treated for rust and/or painted in accordance with MIL-T-704. Paint shall be smooth and uniform without runs and sags. Machined metal surfaces should be rust-free and be lightly coated with grease.

b. Component junctions.

- 1) Rivet holes shall be accurately punched or drilled and should have all burrs removed. Rivets shall be of a size to completely fill holes, allow for a sufficient flare-over concentric with the rivet holes, and be in full contact with the surface of the member.
- 2) Soldering shall be smooth, sound, and clean.
- 3) Welding shall be in accordance with MIL-W-52574 and be free from slag, cracks, fractures and have a smooth, clean appearance.
- 4) Hardware shall be tightly drawn and of sufficient size and strength to support prime mission with test item fully loaded and operating at maximum speed.
- 5) Seams, joints, and edges shall have a good fit and alignment and there shall be no sharp edges or burrs.

c. Ensure that all controls, indicators, access ports, and points of attachment are marked clearly and legibly as to their function.

d. Verify that all doors and covers have the proper fit and operate easily.

e. Examine the test item and ensure that controls and indicators conform to NEMA IC-1; electrical motors to NEMA MG-1; gasoline engines to general requirements of MIL-E-11275; diesel engines to general requirements of MIL-E-11276; and electrical equipment (starters, relays, switches, etc.) to conform with Joint Industrial Council (JIC) EGP-1-1967.

f. Inspect for improperly protected wiring.

g. Check all electrical cables and connectors for damage and secure mating.

h. Verify that all hardware items are standard and preferred types and sizes.

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i. Verify that all hardware items are match-marked to facilitate reassembly, and, wherever possible, are designed for inherent alignment. Elsewhere, aligning devices such as dowels and guides shall be used to aid reassembly.

j. Verify presence of draft technical manuals.

k. Check dimensions and tolerance of test item, test item components and accessories against values specified in applicable MN or military specification.

l. Verify that all major assemblies and attachments are accessible for maintenance, repair, and replacement without the removal of other major assemblies or installed attachments.

m. Ensure that covers, plates and safety guards which must be removed for component adjustment, servicing, repair, replacement, or maintenance are equipped with quick disconnect fittings.

n. Verify that winterization equipment is provided to start and run test item at the ambient temperature specified in the applicable MN or military specification.

o. If appropriate, verify that the winterization equipment contains an operator's cab heater, an engine coolant and lubrication heater, and a battery heater. Each of these heaters shall supply heated fresh air to the respective areas such that the area being heated is maintained within the temperature range specified while the ambient temperature is at the minimum temperature specified in the applicable MN or military specification. The heaters and heater ducts shall conform to the specifications prescribed in the applicable MN.

p. Ensure that all exposed parts electrically operated or subject to high operating temperatures are insulated, fully enclosed or guarded. Any such component not so safeguarded must have a warning plate permanently attached to the test item warning operating or maintenance personnel of the hazard. Verify that guards are installed over all moving parts that operating personnel are likely to contact and over parts subject to breakage and entanglement with wire ropes. Guards shall also be provided to minimize dripping of oil or grease onto the superstructure floor. Guards and mounting brackets shall be provided to protect fuel tank and lubricating lines from damage due to vibration, accidental physical force and possible electrical shorts.

q. Verify that sufficient and minimum controls required to control and monitor performance and work attitude of test item are provided. All controls and indicators should be designed, fabricated and positioned for ease of operation and maximum efficiency in usage.

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r. Verify that the crane-shovel is constructed such that any of its front-end attachments can be installed on the shovel without the use of special tools and without the installation of additional shafts, drums, clutches, etc.

s. Verify that unless suitably protected against electrolytic corrosion, dissimilar metals as defined in MS 33586 shall not be used in intimate contact with each other.

t. Verify that human factors engineering characteristics are incorporated into the crane-shovel design and fabrication. In particular, verify adequate adjusting devices to comfortably allow crane-shovel operation by all sizes of personnel from a small man (fifth percentile) through a large man (ninety-fifth percentile). The operating personnel shall be either lightly dressed (tropic environment) or heavily clothed (arctic environment). Refer to SAE J833 (male physical dimensions for construction and industrial equipment design) for the personnel dimensions of large and small men lightly and heavily clothed.

u. Check that platforms, steps, hand-holds, and catwalks are of the type, number, and positioned as defined in the applicable MN or military specification.

v. Check that the operator's cab in the crane superstructure is constructed of sheet metal of thickness specified in the MN and has sufficient windows and glazed doors to permit 180 degrees of operator vision. Windows shall be openable to ventilate the cab. Waterproof-sealed escape hatches as specified in the MN shall be provided. The location of the seat shall provide the operator with maximum vision of the work area and instruments, and access to hand controls and foot pedals. The seat base shall be provided with a quick release to allow the seat to tilt sideways to permit the operator's escape in case of emergency.

w. Verify that test item lights conform to the applicable portions of the SAE handbook and are shock, moisture, vibration protected, and shielded from damage due to road and work-site splash. Unless otherwise specified, all lighting systems shall be 24 volts. The design, placement, and distance visible of the lighting systems shall be as defined in the applicable MN or military specification. Verify that reflectors of the proper number, size, and location are provided.

x. Verify that boom hoist, swing, and crowd mechanisms (drums, pulleys, cables, clutches, brakes) agree in number and type with those described in the applicable MN or military specifications.

y. Ensure that all drum sizes and brakes agree with specifications described in applicable MN or technical characteristics, and that each drum is independently driven, easily converted and suitable for use with any of the different front-end attachments. The drums should be arranged to minimize eccentric pull to avoid chafing the rope and induce

unequal wear of the drum shaft bearings.

z. Verify the presence of a straight airbrake system, if wheeled vehicle, that complies with the requirements of the ICC motor carrier safety regulations. The airbrake system shall include a fail-safe device such that if the air pressure drops below a preset level, the brakes are automatically energized and set. Parking brakes can use the fail-safe feature to accomplish their function.

aa. Ensure that connectors are provided to utilize external power for emergency battery charging and engine starting.

ab. Verify the presence of a governor to establish and maintain any selected engine speed from idle to the maximum operating speed of the engine.

ac. Carrier assemblies (wheeled or tracked) shall be type and have all principal supporting members as defined in applicable MN or military specification. All shafts, rollers, bearings, gears, etc., shall be provided with guarded grease fittings, and, whenever practicable, the fittings shall be located accessible from outside the base assembly.

ad. If applicable, outriggers consisting of steel beams housed in a suitable metal box attached at right angles to the carrier frame shall be provided. The outriggers shall be located and be long enough to lift all wheels free of the ground and level the test item laterally and longitudinally without the use of blocks, chocks, etc. The outriggers shall be complete with all required jack screws and floats to perform their prime function and not interfere with any of the test item functions when the outriggers are either operative or in their stored position. In addition, the outriggers and floats shall be capable of manipulation into an operable position and then into a stored position, by one man without using special tools or equipment.

ae. If applicable on wheeled assemblies, sufficient controls shall be located in the revolving superstructure cab to permit operator to operate the service brakes; steer the carrier; operate the clutch and shift the transmission gears to reverse, neutral, and first forward gear(s); and control carrier engine speed. (These controls shall not interfere with conventional operation of the superstructure or carrier.)

af. Check all hoses, connections and fittings for fluid leakage.

ag. Inspect all guide and support cables for proper alignment and signs of deterioration.

ah. Verify that, if applicable, the test item is equipped with sufficient lifting attachments to lift the complete crane-shovel with front end attachments removed; each attachment shall be of sufficient strength to carry not less than 2.5 times the normal load imposed on the attachment. In

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addition, the test item shall be equipped with lifting attachments to permit lifting the carrier as a complete unit and the superstructure as a complete unit. Each major subassembly of the two units shall also have lifting attachments for separate transport.

ai. Verify structural integrity, proper design and fabrication, and proper alignment of power train and clutch assemblies. Ensure that sufficient adjustments are provided to compensate for effects of wear.

aj. Verify that a crane-capacity plate is mounted inside the cab in a location conspicuous to the operator. The plate shall be of durable material, permanently mounted, and contain the following information permanently lettered:

- 1) Rated loads in 5-foot increments to full range of operating radii for loads without and (if applicable) with using outriggers. The rating should assume boom in its least stable azimuthal position. When a jib is used, the plate should also give capacity information with jib installed. (The rated load shall not be more than 85 percent of the tipping load.)
- 2) Indication that the rated loads are gross hook-loads at a radius measured from the center of rotation of the revolving superstructure and that the weight of the bucket, piledriver chains, and any other external auxiliary lifting means are to be included as part of the hook-load.
- 3) Statement that the rated loads are based on the crane standing on a supporting surface that is firm, level, and uniform.
- 4) Statement of deduction to be made from the rated loads for components of crane attachments such as jibs of varying size.

ak. Ensure that a telescopic boom stop is furnished to safeguard booms used with the test item from overtopping. The boom stop must prevent the boom from exceeding an angle of 85 degrees above the horizontal, and should provide shock absorber action through not less than four inches of boom travel. The boom stop shall remain assembled when the boom point is lowered to the ground. As the boom point is raised from the ground, the boom stop shall telescope freely without sticking, binding, or bending while the boom point is raised until the boom makes an angle of 85 degrees with the horizontal. The complete boom stop with supporting attachments shall have sufficient strength to develop the ultimate strength of the boom in bending at the point of attachment of the boom stop of the boom.

#### 6.1.2 Inventory Check

Conduct an inventory against the Basic Issue Items List (BIIL). Record evidence of the following:

- 1) Missing maintenance literature or draft technical manuals.
- 2) Shortages in repair parts, accessories, or tools.
- 3) Missing kits.

6.1.3 Inspection and Preliminary Operation

a. Perform periodic inspections(s) and maintenance as required by the draft technical manual and in accordance with applicable inspection procedures of MTP 2-2-502.

b. Establish that the actual test item serial number and the identification number of the engine(s) match those numbers which appear on records accompanying the item.

c. If the test item total elapsed operating time is less than four hours, subject the test item to the break-in procedures of MTP 2-2-505.

6.1.4 Physical Characteristics

Perform the applicable procedures of MTP 2-2-500 and 10-2-500.

6.1.5 Operator Training and Familiarization

Test personnel shall receive training and familiarization with the test item in accordance with applicable procedures of MTP 10-2-501.

6.1.6 Pre-Operational Checks

Perform the following:

a. Depreservation and assembly - remove all preservation from the test item and attach any devices, etc. which are removed from the test item for transporting convenience. Ensure that all connectors, cables, belts, chains, mechanical and hydraulic linkages, etc., are firmly and correctly installed and aligned.

b. Controls, adjustments, and indicators (mechanical, hydraulic, and electrical).

1) Prepare a table listing all devices which control, indicate, or change the operating characteristics of the test item. Arrange the table in the following manner with examples shown:

Electrical Controls	Electrical Indicators	Mechanical/ Hydraulic Controls	Mechanical/ Hydraulic Indicators
Switches Rheostats	Lights Readouts Meters	Levers Wheels Locks Adjustments	Dials Level Gauges

- 2) For each device listed, evaluate and check for the following:
  - a) Operation is correct.
  - b) Effect on test item is as required.
  - c) Operation is smooth.
  - d) Absence of binding, rubbing, leaking.
  - e) Calibration is proper.
  - f) Changes in test item are monitored and displayed correctly.
  - g) Range is correct.

c. Lubrication - verify completeness of the test item lubrication program by considering the following:

- 1) Oil holes, grease fittings, and drain plugs shall be accessible for service without disassembly but designed to exclude foreign material.
- 2) Pressure release fittings will be included where the pressure of lubricating equipment can damage grease seals.
- 3) Periodicity and type of lubricant required will be determined by ambient temperature and work site conditions (sandy, wet, etc.). Refer to draft technical manual for instructions on type lubricant, periodicity of lubrication and points of application. A lubrication tag or chart shall be attached to the test item reporting the following information:
  - a) Points of application.
  - b) Service interval.
  - c) Type of lubricant.
  - d) Viscosity.
  - e) Military specification number.
  - f) Temperature range.
- 4) Units provided with reservoirs, reservoir level gauges, filters and pumping systems in the work position will have all of these features checked for proper operation.

d. Filters - verify that fuel filters and air cleaners are

clean and properly installed.

e. Suppression - ensure that capacitive and inductive radio frequency suppression devices are installed taking note that firm, clean, and tight metal-to-metal contact is maintained.

f. Coolant - verify that engine coolant is installed that is rated for the expected ambient temperature range of test item operation.

g. Battery - verify that the battery electrolyte has been installed and that the battery is fully charged.

h. Hydraulic fluid-using systems - verify that proper hydraulic fluid for all hydraulic systems has been installed

#### 6.1.7 Laboratory and Bench Tests

Pre-engineering tests are required to evaluate, under laboratory conditions, the performance and endurance of the test item major components and thereby establish the suitability of the crane shovel as a system.

##### 6.1.7.1 Electrical Motors and Engines

Electrical motors and engines used in the test item should have their suitability and adequacy determined and verified by testing in accordance with the following:

- a. Electrical motors - MTP 9-2-155.
- b. Reciprocating Internal Combustion Engines.
  - 1) General - MTP 2-2-700.
  - 2) Diesel - MTP 9-2-101 and general requirements of MIL-E-11276.
  - 3) Gasoline - MTP 9-2-102 and general requirements of MIL-E-11275.
  - 4) Effects of Altitude - MTP 2-2-702.

##### 6.1.7.2 Power Train Component Tests

Subject test item power train components (clutch, transmission, transfer case, drive shaft, differential, axles, and brakes) to the procedures of MTP 2-2-703.

##### 6.1.7.3 Tire Tests (If applicable)

Subject test item tire type(s) to the procedures of MTP 2-2-704 and the selection criteria of MIL-T-46729.



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6.1.7.4 Exhaust System Tests

Subject test item exhaust system to the toxic fumes test procedures of MTP 2-2-614.

6.1.7.5 Center of Gravity Determination

Determine the vertical and horizontal center of gravity by utilization of applicable procedures of MTP 2-2-800 and Method 4001 of MIL-STD-488, as appropriate.

6.1.7.6 Clutch Pedal Test

To determine the force required to depress the test item clutch pedal(s), proceed as follows for each clutch pedal:

a. Obtain a scale indicating device (pressure-type) or the equivalent, which is suitable for attaching to the test item clutch pedal.

b. Thermally stabilize the test item at standard ambient temperature. Record the temperature.

c. With the associated engine not running, depress the clutch pedal several times to ensure proper lubrication.

d. Attach the indicating device to the clutch pedal.

e. Apply pressure slowly and evenly until the clutch pedal is depressed to within one inch of the floor plate. Record the maximum gage reading.

f. Place the gear shift in the neutral position. Set brake.

g. Start the associated engine; allow for a fifteen minute warm-up period. (Follow starting engine instructions for starting, if applicable).

h. Repeat procedural steps d and e. In addition to the maximum gage reading, record any indication of altered clutch pedal operating characteristics.

6.2.7.7 Electrical System Test

Perform the applicable procedures of MTP 2-2-601 and record all results.

6.1.7.8 Cooling System Tests

Perform the applicable procedures of MTP 2-2-607 and record all results.

6.1.7.9 Kit Evaluation

Evaluate kits in accordance with applicable procedures of MTP 2-2-707.

6.1.7.10 Personnel Heating and Ventilation

Perform the applicable procedures of MTP 2-2-708 and record all results.

6.1.7.11 Load Distribution and Ground Pressure

Perform the applicable procedures of MTP 2-2-801 and record all results.

6.1.7.12 Wire or Rope Strength Factors

Using an appropriate tensile strength testing machine, determine and record the following for each type of wire rope used on the crane shovel.

a. F, breaking force in tons.

b. C, cross-sectional area of unstretched sample (in square inches).

c. S, rate of travel of power actuated grip.

Compare strength of each rope with general values specified in SAE J959; record any deviation.

6.1.7.13 Crane Shovel Basic Operating Control Arrangements

Compare the layout of crane shovel controls with suggested positions provided in SAE J983. Record a qualitative statement as to agreement/deviations with suggested positions and an evaluation as to the increase/decrease of operator efficiency/confusion resulting from the changed positions.

6.2 TEST CONDUCT

NOTE: All equipment malfunctions shall be reported by EPR in accordance with USATECOM Regulation 70-23.

6.2.1 Crane Stability

Crane stability is determined by attaching an appropriate boom, hook block, and hook to the crane shovel and completing the procedures in method 2101 of MIL-STD-448. Record the force required (tons) to induce tipping as a function of boom position, length of boom used, and working radius. If applicable, force should be recorded both with and without outriggers positioned for normal operation. (Boom should be positioned to

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its least stable position and working radius should be incremented in 5-foot steps from minimum to maximum.)

#### 6.2.2 Load Strain Test

This test determines the ability of the crane shovel to withstand operational stresses induced by lifting, swinging, and lowering loads at 117 percent of maximum crane rating. To complete the test, obtain an appropriate boom, hook block and hook. Prepare the crane shovel for operation as a lift crane and perform the following operations.

- a. Position the lift crane in a suitable work site.
- b. If applicable, set outriggers for normal operation.

c. Use SR-4 resistance strain gages conforming to Baldwin-Lima-Hamilton Corporation Bulletin 279 and 279A to measure frame stress. Locate strain gages midway on superstructure members that provide principal support to crane boom, hoist drums, sheaves and gantry.

NOTE: Exercise care not to tip crane while completing the following steps. If tipping condition is approached, reduce load until safe and complete test. Report load, boom position and working radius that induced tip.

d. Complete step e., with working radius set first at minimum, then, at minimum plus five feet and so on in increments of five feet until maximum working radius is reached.

e. Zero all strain gages. Lift load equal to 117 percent of maximum value allowed for boom angle. Swing load first clockwise 540 degrees, then, counterclockwise 540 degrees. Lower load until held stationary a few inches above ground. Read and record all strain gage indications. Lower load to ground; remove load and record all strain gage indications.

f. Zero all strain gages. Lower boom to ground and raise boom to maximum elevation using the boom hoist mechanism; record all strain gage indications.

#### 6.2.3 Crane Hoist Line Speed and Power Test

Perform the procedures described in SAE J810 (Crane Hoist Line Speed and Power Test) and record all results when load value, set in turn, to 25, 50, 75 and 100 percent of maximum.

#### 6.2.4 Mobility

Determine the mobility of the crane shovel by propelling the

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test item over a suitable cross-country course (such as the Perryman course at Aberdeen Proving Ground) for sufficient time to record a narrative description of the crane mobility; in addition the applicable portions of MTP 2-2-619 and the following test procedures shall be completed to quantitatively ascertain the factors affecting crane shovel mobility.

- a. Turning clearance - Method 1003 of MIL-STD-448.
- b. Crane Travel Speed - Method 1101 of MIL-STD-448.
- c. Vehicle Mobility Index - Method 1004 of MIL-STD-448.
- d. Reserve Tractive Ability - Method 1001 of MIL-STD-448.
- e. Gradeability of Side Slope Performance Test - perform applicable procedures of MTP 2-2-610 and the following slope performance test.

NOTE: In completing the applicable procedures of MTP 2-2-610, exercise extreme caution not to tip or otherwise cause a loss-of-control condition of the crane shovel. For this reason, and unless otherwise specified, limit slope and grade tests to a maximum of 30 percent.

- 1) Run the crane propelling engine for 5 minutes at low idle speed with the crankcase oil level at the low mark on the oil level indicator and with the right side of the crane downhill on a 30-percent slope or simulated slope. Record actual value.
- 2) Repeat 1) with the left side of the crane downhill. Record actual value.
- 3) Repeat 1) with the front of the crane downhill on a 30-percent slope or simulated slope. Record actual values.
- 4) Repeat 1) with the rear of the crane downhill on a 30-percent slope.
- 5) Run the crane engine for 15 minutes at top governed speed with the crankcase filled to the full level and with the right side of the crane downhill on a 30-percent slope or simulated slope. Record actual values.
- 6) Repeat with the left side of the crane downhill. Record actual value.
- 7) Repeat 5) with the front of the crane downhill on a 30-percent slope or simulated slope.
- 8) Repeat 5) with the rear of the crane downhill on a 30-percent slope or simulated slope.
- 9) Record evidence of tractor engine damage, overheating, and/or loss of performance during conduct of 1) through 8).

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f. Foring - MTP 2-2-612.

g. Acceleration - Maximum and Minimum Speeds - MTP 2-2-602.

h. Steering Test (Wheeled Crane Shovel) - Determine test item steering characteristics in accordance with MTP 2-2-609.

#### 6.2.5 Brake Tests

a. Ascertain the dynamic and static brake characteristics of the carrier for the crane shovel by completing the applicable tests in MTP 2-2-608 and MTP 2-2-610.

b. Verify proper operation of the swing and hoist drum brakes by setting, in turn, each brake and slowly engaging the respective drive mechanism. The brakes should not slip, but hold firm and cause the drive engine to stall. If any brake slips, use instructions in draft technical manual to adjust the brake and repeat test. Record any inability or difficulty to properly adjust brakes.

c. With the crane shovel properly fitted (with boom, shovel, bucket, etc.), fully load, in turn, each of the hoist drums. While drum is loaded and operating, shut off drive engine. The respective drum brake should automatically and positively engage to hold load without any reduction of load elevation. If otherwise, refer to applicable instructions in draft technical manual to adjust brake mechanisms and repeat test. Record any difficulty or inability to satisfactorily complete this test.

#### 6.2.6 Fuel Consumption Test

Determine the fuel consumption characteristics of the test item by completing the applicable procedures of MTP 2-2-603.

#### 6.2.7 Environmental Tests

##### 6.2.7.1 Extreme Climatic Tests

Perform the applicable portions of MTP 2-4-001 (Desert Environmental Test of Wheeled and Tracked Vehicles), MTP 2-4-002 (Arctic Environmental Test of Wheeled and Tracked Vehicles), MTP 2-4-003 (Tropic Environmental Test of Wheeled and Tracked Vehicles) to determine the test item ability to function in environments of climatic extremes. In addition, consult and perform applicable procedures of MTP 2-2-550 (Environmental Factors), MTP 2-2-650 (Cold Starting and Warm-Up), and MTP 2-2-708 (Personnel Heating Systems).

##### 6.2.7.2 Intermediate Climatic Tests

Subject the test item to climatic conditions representative of the Intermediate Climate as defined by AR 70-38. Use the following procedures and applicable tests contained in MIL-STD-810.

6.2.7.2.1 Rain Test -

all results. Perform the applicable procedures of MTP 2-2-815 and record

6.2.7.2.2 Low Temperature Test -

all results. Perform the applicable procedures of MTP 2-2-816 and record

6.2.7.3 High Temperature Tests -

all results. Perform the applicable procedures of MTP 2-2-816 and record

6.2.8 Electromagnetic Interference

This test shall be performed in accordance with the requirements of MIL-STD-461, 462, and the applicable portions of MTP 2-2-613. The subtests required of the MIL-STD-461 Class II B (motor used as prime mover), III C (engine used for source of AC or DC power) equipment shall consist of the following:

<u>TEST (IIB)</u>	<u>DESCRIPTION</u>
CEO3	150 kHz to 50 mHz, power leads
CEO5	30 H <sub>z</sub> to 50 mHz, inverse filter method

<u>TEST (IIB)</u>	<u>DESCRIPTION</u>
REO1	0.03 to 30 kHz, magnetic field
REO2	150 kHz to 400 mHz, electric field
REO4	0.02 to 50 kHz, magnetic field

<u>TEST (III C)</u>	<u>DESCRIPTION</u>
REO5	150 kHz to 1GH <sub>z</sub> , vehicles and engine-driven equipment.

- MIL-STD-461.
- Obtain the measuring equipment and antennas required by
  - Calibrate the equipment where required.
  - Have the test item in a normal operating configuration under the test conditions specified by MIL-STD-462.

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d. Conduct the subtests listed above, recording frequencies and levels of interference.

e. Compare the interference readings against the allowable limit graphs of MIL-STD-461 and note out-of-tolerance readings.

6.2.9            Durability

Operate the test item carrier and cycle the crane lifting function as described in MPTS 2-2-506, 2-2-507, and 9-2-503. Record all results.

6.2.10           Transportability

Perform the applicable portions of MTP 10-2-503 and record all results.

6.2.11           Maintenance Evaluation

Evaluate the maintenance-related factors of the test item as described in MTP 10-2-507 and 2-2-503.

6.2.12           Reliability

Evaluate and appraise the reliability related factors of the test item as described in MTP 10-2-512.

6.2.13           Safety

This test is to evaluate the safety characteristics and features of the test item. The requirements of the following documents will apply:

- a. Safety Evaluation MTPS 2-2-508 and 10-2-508.
- b. System Safety Program for Systems and Associated Subsystems and Equipment: Requirements for; MIL-STD-882.
- c. Operation of Power Shovels, Dragline and Similar Equipment, Data Sheet D-271, Stock No. 12304; Wire Rope, Safe Loads for Sling, Data Sheet D-380, Stock No. 12304; and Safe Use of Heavy Duty Equipment on Construction Jobs, Industrial Safety Reprint No. 130, Stock No. 12913.
- d. 125 Ways to Better Shovel-Crane Operation.
- e. American Standard Safety Code for Cranes, Derricks, and Hoists, B30. 2-1943, 1952.

In addition, ensure strict compliance with all safety precautions listed in Appendix A.

6.2.14 Human Factors Evaluation

Perform the applicable portions of MTPs 2-2-803 and 10-2-505 and record all results.

6.2.15 Value Analysis

During the conduct of all tests, personnel shall examine the materials, construction, and design of the test item from a value standpoint in an effort to effect cost reduction of the test item. USATECOM Regulation 700-1 shall serve as a basis for this evaluation. Perform the following:

a. Examine the test item in the following cost reduction areas:

- 1) Deletion of ineffective or unnecessary features of components.
- 2) Substitution of less expensive but comparable component or material.
- 3) Changes in the design to reduce the cost of manufacturing.

b. Examine all proposals to determine that the performance and safety characteristics have not been lowered.

c. Record the following for each suggested change:

- 1) Component or feature involved.
- 2) Suggested change.
- 3) Reasons for the suggestion.



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6.2.16            Quality Assurance

Throughout all tests, examine the test item for compliance with the quality requirements of the applicable MN and the provisions of MTP 10-2-511.

6.3                TEST DATA

6.3.1            Preparation for Test

6.3.1.1          Initial Inspection

Record data required by documents defined by 6.1.1

6.3.1.2          Inventory Check

Record data required by 6.1.2

6.3.1.3          Inspection and Preliminary Operation

Record data required by MTPS 2-2-502 and 2-2-505.

6.3.1.4          Physical Characteristics

Record data required by MTPS 2-2-500 and 10-2-500.

6.3.1.5          Operator Training and Familiarization

Record data required by MTP 10-2-501.

6.3.1.6          Pre-Operational Checks

Record data required by 6.1.6

6.3.1.7          Laboratory and Bench Tests

Record data required by 6.1.7.

6.3.2            Test Conduct

6.3.2.1          Crane Stability

Record data required by 6.2.1

6.3.2.2          Load Strain Test.

Record data required by 6.2.2.

6.3.2.3          Crane Hoist Line Speed and Power

Record data required by 6.2.3.

- 6.3.2.4      Mobility  
Record data required by 6.2.4
- 6.3.2.5      Brake Test  
Record data required by 6.2.5
- 6.3.2.6      Fuel Consumption  
Record data required by MTP 2-2-603.
- 6.3.2.7      Environmental Tests  
Record data required by 6.2.7
- 6.3.2.8      Electromagnetic Interference  
Record data required by 6.2.8
- 6.3.2.9      Durability  
Record data required by MTPS 2-2-506, 2-2-507 and 9-2-503.
- 6.3.2.10     Transportability  
Record data required by MTP 10-2-503.
- 6.3.2.11     Maintenance Evaluation  
Record data required by MTPS 10-2-507 and 2-2-503.
- 6.3.2.12     Reliability  
Record data required by MTP 10-2-512.
- 6.3.2.13     Safety  
Record data required by 6.2.13
- 6.3.2.14     Human Factors Evaluation  
Record data required by MTPS 2-2-803 and 10-2-505.
- 6.3.2.15     Value Analysis  
Record data required by 6.2.15
- 6.3.2.16     Quality Assurance  
Record data required by 6.2.16.

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6.4 DATA REDUCTION AND PRESENTATION

6.4.1 Laboratory and Bench Tests

6.4.1.1 Wire-Rope Strength Factors.

Compute and record the tensile strength of each rope tested:

6.4.2 Test Conduct

6.4.2.1 Crane Hoist Line Speed and Power.

For each load condition and hoist drum, compute and record the horsepower developed by the hoist mechanism.

6.4.2.2 Mobility

6.4.2.2.1 Steering characteristics

For each steering subtest compute and record the following information.

$$W \text{ (foot lbs.)} = D \times F$$

where W = work to steer.

D = distance in feet through which force (F) acts (1/2 diameter of steering wheel, entire length of pedal or lever travel).

F = force or gage indication in pounds associated with steering action.

6.4.3 General

Tabulate, summarize, and graph the remaining data as appropriate. All data should be compared with the technical performance characteristics specified in the MN's or other development criteria. In addition, the report should include a written statement as to the suitability of the test item for service test.

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APPENDIX A

Safety Precautions

1. Stop the machine when work must be done around gears, sheaves, drums, and similar parts.
2. Do not jump from the unit to the ground. Use handholds or steps. Keep walking surfaces clear of ice, snow, grease, and other materials which cause slippery conditions. Keep revolving frame floors free of grease and mud to prevent slipping and falling.
3. Do not attempt to get on or off the unit while it is in motion.
4. Do not give the operator a signal to raise the load until hooks or chains are properly secured.
5. If the hook is not clearly visible to the operator, use an intermediate signalman. Lift loads vertically so they will not swing. Watch the load at all times when operating the unit.
6. Be sure to stay within the maximum working radius for the load being lifted.
7. Be sure there is adequate clearance before attempting to move the machine under bridges, power lines, and other low objects.
8. Keep the boom at least 10 feet from all electrical lines. Before operating, be sure there is adequate clearance to swing the boom point and rear of the unit without hitting any objects. Do not exceed capacity ratings.
9. Do not move the machine while the boom is at a high angle. Do not move the machine while carrying close to maximum loads.
10. To move capacity loads beyond the radius of the machine, pick up the load, swing it ahead, set it down, and then move around it. Repeat as often as necessary.
11. When traveling with a suspended load, secure it to the machine to prevent it from swaying out beyond the boom point.
12. Keep the lift height to a minimum when lifting close to maximum loads. Never leave the machine with the dipper, bucket, or crane load in the raised position. Lower the load and disengage the engine clutch.
13. Start and stop the revolving frame slowly to lessen change of tilting the unit.

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